J. PHILLIP CARVER
General Attorney

BellSouth Telecommunications, Inc.
150 South Monroe Street
Room 400
Tallahassee, Florida 32301
(404) 335-0710

October 12, 1998

Mrs. Blanca S. Bayó
Director, Division of Records and Reporting
Florida Public Service Commission
2540 Shumard Oak Boulevard
Tallahassee, FL 32399-0850

Re: **Docket No. 980696-TP**

Dear Ms. Bayó:

Enclosed are an original and one copy of BellSouth Telecommunications, Inc.'s Late Filed Exhibit Nos. 2 and 3 for Kevin Duffy-Deno. Please file these in the captioned matter.

A copy of this letter is enclosed. Please mark it to indicate that the original was filed and return the copy to me. Copies have been served to the parties shown on the attached Certificate of Service.

Sincerely,

J. Phillip Carver (cr)

J. Phillip Carver

Enclosures

cc: All parties of record
    A. M. Lombardo
    R. G. Beatty
    William J. Ellenberg II (w/o enclosures)

CERTIFICATE OF SERVICE
DOCKET NO. 980696-TP (HB4785)

I HEREBY CERTIFY that a true and correct copy of the foregoing was served via Federal Express this 12th day of October, 1998 to the following:

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J. Phillip Carver (kp)
J. Phillip Carver

(+) Protective Agreements

3

REQUEST: Identification of MST Analysis for Florida Using Satellite Information.

RESPONSE:

The attached spreadsheet shows the results of applying the minimum spanning tree (MST) analysis to the actual house locations in the Yankeetown FL wire center. Specifically, the spreadsheet shows, at the top, the wire center MST for the actual locations and then the wire center MST for the actual locations uniformly distributed along the boundaries of the Census Blocks in which they occur. The result of the analysis indicates that **when a consistent geographic entity is used, e.g., Census Block, and when 100% actual locations are replaced with 100% surrogate locations,** distributing locations along the Census Block boundary yields a greater dispersion than that which is characteristic of the actual locations. The remaining data in the spreadsheet show the same analysis Census Block by Census Block.

Care should be taken in applying these findings to the surrogate customer (non-address-geocoded) placement used in the Hatfield model.

First, the PNR clusters can span multiple Census Blocks. The surrogate placement methodology is not conservative if it leads to clustering of surrogate locations on contiguous Census Blocks borders.

Second, the findings in the attached spreadsheet depend critically on the assumption that the geographic entity remains the same. That is, changing the placement of customers from part address-geocoded to entirely surrogate will change the shape, size, and composition of the PNR clusters. A direct comparison of the level of dispersion using all surrogates with that which occurs using part or entirely geocoded is not possible using the PNR clusters.

Finally, the MST analysis of the Hatfield Model presented in the rebuttal testimony of Dr. Duffy-Deno is unaffected by these findings. The MST analysis of the Hatfield Model tests whether the Model estimates at least enough cable distance to connect customers **in the locations identified by the Model,** i.e., in the PNR clusters, **not** in their actual locations. Since we do not have a comprehensive database of actual customer locations in FL, the MST test is a test of the Model's internal consistency.

Yankeetown Wire Center: MST Comparisons
(Surrogate points uniformly distributed around CB periphery)

	MST Length in Feet		Comparison	
	Observed Points	Surrogate Points	Observed Shorter By %	Surrogate Longer by %
Whole Wire Center	927,092	1,170,741	20.80%	26.30%
By Census Block				
12075970400110	8,448	14,747	42.70%	74.60%
12075970400112A	0	0	---	---
12075970400119	313	2,067	84.90%	560.40%
12075970400120	927	2,414	61.60%	160.40%
12075970400125A	4,637	11,466	59.60%	147.30%
12075970400125B	6,418	9,526	32.60%	48.40%
12075970400128	0	0	---	---
12075970400129A	2,360	4,918	52.00%	108.40%
12075970400131	5,166	27,687	81.30%	435.90%
12075970400132	513	3,090	83.40%	502.30%
12075970400134	0	0	---	---
12075970400135	733	1,487	50.70%	102.90%
12075970400136	6,294	16,232	61.20%	157.90%
12075970400142	34,554	50,797	32.00%	47.00%
12075970400143	2,684	3,379	20.60%	25.90%
12075970400144	17,340	35,097	50.60%	102.40%
12075970400147	24,656	45,417	45.70%	84.20%
12075970400150	7,992	11,941	33.10%	49.40%
12075970400152	20,622	24,421	15.60%	18.40%
12075970400153	98,584	111,311	11.40%	12.90%
12075970400156	0	0	---	---
12075970400161	0	0	---	---
12075970400418	21,750	54,749	60.30%	151.70%
12075970400419	60,339	83,550	27.80%	38.50%
12075970400420	0	0	---	---
12075970400422	73,642	94,600	22.20%	28.50%
12075970400426	0	0	---	---
12075970400497	11,184	21,074	46.90%	88.40%
12075970700101	50,050	84,613	40.80%	69.10%
12075970700123	1,180	7,526	84.30%	537.80%
12075970700125	4,350	10,647	59.10%	144.80%
12075970700127	4,749	8,712	45.50%	83.40%
12075970700128	0	0	---	---
12075970700135	0	0	---	---
12075970700139	0	0	---	---
12075970700140	0	0	---	---
12075970700141	0	0	---	---
12075970700145	7,548	16,705	54.80%	121.30%
12075970700146	0	0	---	---
12075970700149B	30,210	43,990	31.30%	45.60%
12075970700150	23,736	29,422	19.30%	24.00%

12075970700151	3,098	4,222	26.60%	36.30%
12075970700154	26,309	73,433	64.20%	179.10%
12075970700157	0	0	---	---
12075970700160	22,924	35,206	34.90%	53.60%
12075970700162	560	937	40.20%	67.30%
12075970700163	1,990	3,516	43.40%	76.70%
12075970700164	2,062	3,392	39.20%	64.50%
12075970700165	1,648	2,892	43.00%	75.50%
12075970700166	6,627	11,245	41.10%	69.70%
12075970700167	0	0	---	---
12075970700168	6,874	12,230	43.80%	77.90%
12075970700170	4,162	5,577	25.40%	34.00%
12075970700171	1,339	2,280	41.30%	70.30%
12075970700172	0	0	---	---
12075970700173	2,112	3,704	43.00%	75.40%
12075970700174	1,453	2,824	48.50%	94.40%
12075970700175	293	897	67.30%	206.10%
12075970700176	19,564	31,510	37.90%	61.10%
12075970700178	1,938	3,297	41.20%	70.10%
12075970700179	1,743	2,529	31.10%	45.10%
12075970700180	554	943	41.30%	70.20%
12075970700181	0	0	---	---
12075970700182	107	368	70.90%	243.90%
12075970700201A	13,659	23,552	42.00%	72.40%
12075970700201B	1,281	10,210	87.50%	697.00%
12075970700201C	8,784	18,815	53.30%	114.20%
12075970700202	262	4,105	93.60%	1466.80%
12075970700203	1,235	5,070	75.60%	310.50%
12075970700204	0	0	---	---
12075970700205	0	0	---	---
12075970700208	808	3,052	73.50%	277.70%
12075970700212A	2,721	4,215	35.40%	54.90%
12075970700212B	1,544	1,973	21.70%	27.80%
12075970700213A	2,568	4,188	38.70%	63.10%
12075970700213B	554	1,612	65.60%	191.00%
12075970700214A	2,985	4,476	33.30%	49.90%
12075970700214B	390	990	60.60%	153.80%
12075970700215A	2,107	4,170	49.50%	97.90%
12075970700215B	606	1,200	49.50%	98.00%
12075970700216	2,453	2,927	16.20%	19.30%
12075970700217	3,068	4,927	37.70%	60.60%
12075970700218	3,955	5,786	31.60%	46.30%
12075970700219	2,485	5,488	54.70%	120.80%
12075970700220	2,460	4,305	42.90%	75.00%
12075970700222	2,524	3,285	23.20%	30.20%
12075970700223	3,273	5,222	37.30%	59.50%
12075970700228	931	1,621	42.60%	74.10%
12075970700229	0	0	---	---
12075970700230	3,062	5,641	45.70%	84.20%
12075970700231	2,774	5,320	47.90%	91.80%
12075970700232	0	0	---	---

12075970700235	984	1,684	41.60%	71.10%
12075970700236	171	600	71.50%	250.90%
12075970700239	0	0	---	---
12075970700240	823	1,754	53.10%	113.10%
12075970700241	166	385	56.90%	131.90%
12075970700242	2,006	3,391	40.80%	69.00%
12075970700243	3,730	5,616	33.60%	50.60%
12075970700244	2,863	5,245	45.40%	83.20%
12075970700245	882	1,743	49.40%	97.60%
12075970700246	1,677	3,795	55.80%	126.30%
12075970700247	255	861	70.40%	237.60%
12075970700248	178	358	50.30%	101.10%
12075970700249	698	1,603	56.50%	129.70%
12075970700250	698	2,175	67.90%	211.60%
12075970700251	0	0	---	---
12075970700254	498	1,052	52.70%	111.20%
12075970700255	425	1,053	59.60%	147.80%
12075970700256	3,375	4,182	19.30%	23.90%
12075970700257A	7,492	8,982	16.60%	19.90%
12075970700260A	3,353	4,311	22.20%	28.60%
12075970700260B	1,170	2,748	57.40%	134.90%
12075970700261	1,630	4,421	63.10%	171.20%
12075970700262A	406	1,918	78.80%	372.40%
12075970700262B	369	1,108	66.70%	200.30%
12075970700264B	6,168	14,226	56.60%	130.60%
12075970700301	2,140	6,400	66.60%	199.10%
12075970700302	1,755	3,169	44.60%	80.60%
12075970700303	1,062	1,846	42.50%	73.80%
12075970700304	1,366	2,014	32.20%	47.40%
12075970700305B	4,872	7,822	37.70%	60.60%
12075970700306B	233	705	67.00%	202.60%
12075970700307A	295	1,549	81.00%	425.10%
12075970700307B	367	2,202	83.30%	500.00%
12075970700308A	1,791	2,350	23.80%	31.20%
12075970700309	1,513	2,318	34.70%	53.20%
12075970700310	1,570	2,230	29.60%	42.00%
12075970700311	1,564	2,556	38.80%	63.40%
12075970700312	1,253	2,065	39.30%	64.80%
12075970700313	1,429	2,304	38.00%	61.20%
12075970700314	998	1,593	37.40%	59.60%
12075970700315	626	1,289	51.40%	105.90%
12075970700316	735	1,130	35.00%	53.70%
12075970700317	0	0	---	---
12075970700318A	582	2,499	76.70%	329.40%
12075970700319A	4,183	4,199	0.40%	0.40%
12075970700319B	3,318	4,942	32.90%	48.90%
12075970700320A	5,318	9,656	44.90%	81.60%
12075970700320C	2,937	4,883	39.90%	66.30%
12075970700321	693	2,637	73.70%	280.50%
12075970700323	2,828	4,033	29.90%	42.60%
12075970700324A	1,704	3,261	47.70%	91.40%

12075970700325A	235	1,388	83.10%	490.60%
12075970700325B	938	3,979	76.40%	324.20%
12075970700326A	3,321	4,986	33.40%	50.10%
12075970700327	5,046	7,556	33.20%	49.70%
12075970700330	0	0	---	---
12075970700332	881	1,821	51.60%	106.70%
12075970700333	532	1,447	63.20%	172.00%
12075970700334	0	0	---	---
12075970700335A	3,482	5,423	35.80%	55.70%
12075970700337	0	0	---	---
12075970700338	423	987	57.10%	133.30%
12075970700339	1,523	2,628	42.00%	72.60%
12075970700340	583	1,517	61.60%	160.20%
12075970700341	823	1,659	50.40%	101.60%
12075970700343	2,886	4,173	30.80%	44.60%
12075970700344	2,558	4,529	43.50%	77.10%
12075970700347	0	0	---	---
12075970700348	2,920	4,658	37.30%	59.50%
12075970700349	583	1,158	49.70%	98.60%
12075970700350	627	2,589	75.80%	312.90%
12075970700407	8,712	14,474	39.80%	66.10%
12075970700408	103	645	84.00%	526.20%
12075970700409	0	0	---	---
12075970700410	0	0	---	---
12075970700411	0	0	---	---
12075970700412	293	720	59.30%	145.70%
12075970700414	440	720	38.90%	63.60%
12075970700415	572	980	41.60%	71.30%
12075970700416	1,061	1,994	46.80%	87.90%
12075970700417	903	1,990	54.60%	120.40%
12075970700418	850	1,199	29.10%	41.10%
12075970700419	651	1,613	59.60%	147.80%
12075970700420	11,735	19,538	39.90%	66.50%
12075970700421	238	703	66.10%	195.40%
12075970700422	640	1,478	56.70%	130.90%
12075970700423	200	598	66.60%	199.00%
12075970700424	1,486	2,272	34.60%	52.90%
12075970700425	390	947	58.80%	142.80%
12075970700426	1,060	2,215	52.10%	109.00%
12075970700427	296	978	69.70%	230.40%
12075970700428	636	1,870	66.00%	194.00%
12075970700432	967	1,998	51.60%	106.60%
12075970700434	0	0	---	---
12075970700435	422	813	48.10%	92.70%
12075970700436	466	987	52.80%	111.80%
12075970700437	1,253	1,938	35.30%	54.70%
12075970700438	1,419	1,863	23.80%	31.30%
12075970700439	1,236	1,688	26.80%	36.60%
12075970700440	582	956	39.10%	64.30%
12075970700441	1,409	1,794	21.50%	27.30%
12075970700442	4,279	5,348	20.00%	25.00%

12075970700443	535	945	43.40%	76.60%
12075970700444	1,842	2,779	33.70%	50.90%
12075970700445	1,873	2,752	31.90%	46.90%
12075970700446	1,278	2,202	42.00%	72.30%
12075970700447	1,139	2,018	43.60%	77.20%
12075970700448	1,627	2,325	30.00%	42.90%
12075970700450	7,197	19,042	62.20%	164.60%
12075970700452	7,618	17,470	56.40%	129.30%
12075970700454	2,569	4,927	47.90%	91.80%
12075970700455	0	0	---	---
12075970700456	0	0	---	---
12075970700457	282	444	36.50%	57.40%

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO. 980696-TP

REBUTTAL TESTIMONY
OF DR. KEVIN T. DUFFY-DENO
ON BEHALF OF BELLSOUTH TELECOMMUNICATIONS, INC.

SEPTEMBER 2, 1998

Table of Contents

REBUTTAL TESTIMONY

OF DR. KEVIN T. DUFFY-DENO

ON BEHALF OF BELLSOUTH TELECOMMUNICATIONS, INC.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO. 980696-TP

SEPTEMBER 2, 1998

1 I.   INTRODUCTION

2

3 Q.   PLEASE STATE YOUR NAME AND BUSINESS AFFILIATION.

4 A.   My name is Kevin T. Duffy-Deno. I am the Managing Director-Market Research

5   at *INDETEC* International, a telecommunications consulting firm.

6

7 Q.   ARE YOU THE SAME KEVIN T. DUFFY-DENO WHO FILED DIRECT

8   TESTIMONY IN THESE PROCEEDINGS?

9 A.   Yes.

10

11 Q.   WHAT IS THE PURPOSE OF YOUR TESTIMONY?

12 A.   The primary purpose of my testimony is to respond to Mr. Wood's assertion in his

13   testimony of August 3, 1998 on page 20 that:

14

15   "By developing costs based on the actual locations of most customers, this release

16   of the HAI Model provides a degree of precision in its results that simply cannot

17   be duplicated by a model such as the BCPM which uses a more simplistic

18   approach of arbitrarily distributing end users along roadways or within an

1   artificial grid structure."

2

3   My testimony provides theoretical and empirical evidence that refutes Mr.

4   Wood's assertion. This evidence consists of a relative evaluation of three key

5   features of the HAI Model Release 5.0a (HAI 5.0a) and the Benchmark Cost

6   Proxy Model Release 3.1 (BCPM 3.1): (1) the customer location methodology;

7   (2) the customer aggregation methodology; and (3) a comparison of the minimum

8   distance, as the crow flies, required to connect customers and the distribution

9   plant provisioned in HAI 5.0a.

10

11   Q.   PLEASE SUMMARIZE YOUR PRIMARY FINDINGS AND CONCLUSIONS.

12   A.   The following summarizes key evidence that counters Mr. Wood's assertion that

13   HAI 5.0a is more "precise" than BCPM 3.1.

14

15   • The rate of successful geocoding is extremely low in the rural, low-density

16   areas of Florida. Consequently, the HAI Model customer location methodology is

17   reduced to estimating the lion's share of customer locations in these areas. HAI

18   simply places such customers on the perimeter of relatively large Census Blocks,

19   ignoring the importance of placing customers along interior roads.

20   • The HAI's sponsors claim that the model accurately locates customers

21   remains unsubstantiated because AT&T has refused to allow anyone access to the

22   underlying geocoded and surrogate data to BellSouth for Florida.

23   • The rectangular HAI clusters to which the HAI model engineers plant, do not

24   fully encompass the underlying geocoded and surrogate locations upon which these

25   HAI clusters are based. The geocoded and surrogate locations themselves are not

3

1   used in the HAI model.

2   • An analysis of the Yankeetown wire center in Levy County indicates that

3   BCPM's customer location methodology effectively identifies the actual distribution

4   of customers within this wire center.

5   • An analysis of whether HAI 5.0a estimates the minimum distance needed to

6   connect all of the customers in their main cluster locations identified by the model

7   indicates that HAI 5.0a substantially underestimates this distance by 1,866 miles for

8   BellSouth's Florida territory. In the lowest density zone, the model's estimated

9   distribution distance (including drop and connecting cable) is less than this minimum

10   connecting distance in 87% of its main clusters. Hence, HAI 5.0a's distribution plant

11   substantially underestimates the requisite plant by a substantial margin to provide

12   basic service, particularly in rural areas.

13   • In contrast to the pronounced internal inconsistency in HAI 5.0a determination

14   of requisite distribution plant, a comparable analysis of BCPM 3.1 reveals that

15   BCPM's modeling of distribution plant is internally consistent with BCPM's

16   modeling intent. The minimum connecting distance analysis of BCPM 3.1 indicates

17   that BCPM is only 465 miles short in the lowest density zone and short in only 32%

18   of its ultimate grids.

19

20   Q.   HOW IS YOUR REBUTTAL TESTIMONY ORGANIZED?

21   A.   Section II provides an overview of HAI 5.0a's and BCPM 3.1's customer location

22   methodology and an evaluation of the two methodologies.   Section III provides

23   similar information for the model's customer aggregation methodologies. The

24   models' provision of distribution plant is addressed in Section IV. A summary of

25   key points is provided in Section V.

4

1

2 Q.   ARE THERE EXHIBITS TO YOUR TESTIMONY?

3 A.   Yes. The following is a list of the Exhibits that accompany my testimony:

4

5   KDD-1   The Road Network in Dixie County, FL

6   KDD-2   Geocoded Locations in Dixie County, FL

7   KDD-3   Geocoded Locations in Levy County, FL

8   KDD-4   Geocoded Locations in Washington County, FL

9   KDD-5   Satellite Observations in the Yankeetown Wire Center, FL

10   KDD-6   Effect of Surrogate Point Placement On Minimum Spanning Tree

11   Length

12   KDD-7   March 2, 1998 AT&T *ex parte* to the FCC

13   KDD-8   Concentric Ring Analysis of the Yankeetown Wire Center, FL

14   KDD-9   Figure 1. Yankeetown Wire Center: Distribution of Actual and

15   BCPM predicted Counts.

16   KDD-10   BCPM Ultimate Grids in the Yankeetown Wire Center, FL

17   KDD-11   HAI Distribution Cable Requirements

18   KDD-12   HAI 5.0a Clusters in the Yankeetown Wire Center, FL

19   KDD-13   Figure 2. Stylized PNR Polygon Cluster and the HAI Equivalent-

20   area rectangle (Access Database); Figure 3. Formation of the HAI

21   5.0a Rectangular Clusters

22   KDD-14   Using Minimum Spanning Trees to Estimate Subscriber

23   Dispersion and Minimum Network Length

24   KDD-15   The "Shorter-Than-Minimum-Spanning-Tree" Fallacy

25

1

2   II.   CUSTOMER LOCATION

3   A.   HAI 5.0a Customer Location Methodology

4   Q.   HOW DOES HAI 5.0a LOCATE CUSTOMERS?

5   A.   As explained in the HAI Model Documentation, "address geocoding" is used to

6   spatially locate customers. First, an address database is acquired from a source

7   such as Metromail, which supplies addresses to the mass-mail marketing industry.

8   These addresses are then input to geocoding software, which then determines the

9   latitude and longitude of the address on a map of the road-network.

10

11   When customers cannot be accurately address-geocoded, their locations are

12   placed uniformly on the perimeter of the Census Block in which they are located.

13   These estimated customer locations are called "surrogate" locations.

14

15   Q.   OF THE COMPLETE ADDRESSES METROMAIL PROVIDES, CAN THE

16   LOCATIONS OF ALL CUSTOMERS BE ADDRESS-GEOCODED?

17   A.   No. P.O. Box and Rural Route addresses cannot be accurately geocoded. Since

18   P.O. Boxes and Rural Route addresses occur much more frequently in rural areas,

19   this affects the ability to geocode in rural areas substantially more than it affects

20   geocoding in the urban areas.

21

22   Failure to address-geocode may also result from incomplete information in the

23   road network database. For example, consider a fictional Mrs. Emma Jones who

24   lives at 120 Town Road. To accurately geocode Mrs. Jones' location, one needs

1   three pieces of information in the road network database. First, the physical road

2   segment Town Road, the portion of road between two intersections, needs to be in

3   the database. Second, the physical road segment must be identified with the name

4   "Town Road." Finally, the address range associated with "Town Road" must

5   include "120."

6

7   The leading reason why customer locations in rural areas cannot be accurately

8   address-geocoded is this road network information requirement. As an example,

9   Exhibit KDD-1 shows the road network in Dixie County, Florida. Physical road

10   segments are shown in black, named road segments are shown in blue, and named

11   road segments with address ranges are shown in red. Customer locations can only

12   be accurately geocoded to the red road segments. The portion of total road

13   segments that are named and numbered is quite low. Less than 1% of the physical

14   roads in Dixie County are named and have address ranges.

15

16   Q.   WHAT SHARE OF CUSTOMER LOCATIONS COULD BE ADDRESS-

17   GEOCODED IN FLORIDA?

18   A.   The sponsors of HAI 5.0a filed with the FCC an *ex parte* on February 3, 1998

19   which presents the geocode rates obtained by the HAI Model developers, by

20   density zone, for the 50 states. For the < 5 line per square mile density zone, the

21   HAI Model developers could accurately address-geocode the locations of only

22   34% of customers in Florida. The national average was reported as being 15% for

23   this density zone. Table 2 below shows all of the geocode rates for Florida.

24

25   **Table 2. HAI 5.0a Address-Geocode Rates for Florida:**

7

1

CBG Density Zone

2

Density Zone	MCI Reported Successful Geocode Rate
0 - 5	34%
5 - 100	62%
100 - 200	80%
200 - 650	85%
650 - 850	84%
850 - 2,550	78%
2,550 – 5,000	64%
5,000 – 10,000	46%
10,000 +	50%

3

4　Q.　IS THERE ANOTHER WAY TO EXAMINE THE GEOCODE RATE IN

5　　　FLORIDA OTHER THAN THAT PRESENTED IN TABLE 2?

6　A.　Yes. Another set of geocode success rates has been provided by AT&T to the

7　　　Fcc to support HAI 5.0a. These data are success rates by Florida wire center.

8　　　These data, shown in Table 3, reveal that no residential customer locations could

9　　　be successfully address-geocoded in 25 wire centers in Florida, or 5.3% of the

10　　total wire centers in Florida.

11

12　　**Table 3. Distribution of HAI Address-Geocode Success Rates for Florida**

13　　　　　　　　　　　　　　　　**Wire Centers.**

14

Geocode Rate	WC Count	WC Share
0%	25	5.33%
0 - 10%	65	13.86%
10 - 20%	25	5.33%
20 - 30%	19	4.05%

30 - 40%	20	4.26%
40 - 50%	25	5.33%
50 - 60%	20	4.26%
60 - 70%	43	9.17%
70 - 80%	78	16.63%
80 - 90%	105	22.39%
90 - 100%	43	9.17%
100%	1	.21%
Total	469	100.00%

1

2   Another way to examine these wire center level data is to categorize wire centers

3   into density zones using wire center level densities (density in Table 2 refers to

4   Census Block Group density, the measure of density used by HAI 5.0a). This

5   approach suggests that the address-geocode rate in the lowest density wire centers

6   is lower than the 34% reported in Table 2. In fact, on average, the success rate in

7   the less than 5 line per square mile density zone is 22%. These data for all HAI

8   wire centers in Florida are shown in Table 4. Wire center area is taken from

9   BCPM 3.1 as the HAI Access database does not provide these data.

10

11   **Table 4. HAI 5.0a Address-Geocode Rates for Florida:**

12   **Wire Center Density Zone**

13

DZ	WC Count	Average Geocode Rate
< 5	19	22.43%
5 - 20	71	23.30%
20 - 100	91	46.83%
100 - 200	52	68.17%

200 - 650	79	72.78%
650 - 850	20	79.84%
850 - 2,550	62	70.16%
2,550 - 5,000	55	60.17%
5,000 - 10,000	18	40.87%
> 10,000	2	21.19%
Total	469	54.74%

1

2 Q.   HAVE YOU EXAMINED THE ADDRESS-GEOCODE RATE FOR RURAL

3   FLORIDA?

4 A.   Yes, I have. Table 5 shows the 1995 Census housing unit count for three

5   randomly selected rural Florida counties. Dixie and Levy Counties are located on

6   the western coast of northern Florida while Washington County is located just

7   east of Eglin Air Force Base. All three counties are characterized by low housing

8   unit densities (i.e., less than 15 housing units per square mile). These counties

9   were selected using a MapBasic random selection program from a list of the

10   state's counties with densities less than 25 housing units per square mile and

11   known to contain a BellSouth owned wire center. Wire centers containing Native

12   American reservations, major state parks, or predominantly water were rejected if

13   they were selected.

14

15   Also shown in Table 5, for each county is the number of Metromail complete

16   addresses provided to INDETEC on July 11, 1998, the number of these addresses

17   that can be geocoded, and hence, the share of 1995 Census housing units that can

18   be geocoded.

19

10

1   **Table 5. Address-Geocoding in Low-Density Counties of Florida**

2

	1995 Census Housing Units	Metromail Complete Addresses	Geocodable Addresses	Census Count Geocodable
Dixie	7,361	216	0	0%
Levy	14,011	7,074	3,748	27%
Washington	8,461	3,794	2,253	27%

3

4   Table 5 clearly shows that the share of total customer locations (Census housing

5   units) that can be geocoded varies across counties and can be extremely low, zero

6   in fact, consistent with the HAI Model sponsor findings.

7

8 Q. YOU MENTIONED THAT THE ADDRESS-GEOCODE RATE DIFFERS

9   BETWEEN RURAL AND URBAN AREAS. CAN YOU PROVIDE

·10   EVIDENCE OF THIS IN THESE RURAL FLORIDA COUNTIES?

11 A. Yes. The geocode rates shown in Tables 2 - 5 do not show the fact that customer

12   locations in towns are much more likely to be geocoded than those out of town.

13   As evidence of this, consider the three maps of wire centers in these counties

14   provided as Exhibits KDD- 2, 3, and 4. These maps show, by red diamonds, the

15   geocoded locations in these wire centers. No customer locations could be

16   geocoded in Dixie County (KDD-2). Usually one sees that in rural counties,

17   geocoded locations tend to occur in clusters, centered on towns. This is the case in

18   both Levy (KDD-3) and Washington (KDD-4) Counties. In Levy County, the

19   geocoded locations are clustered around the towns of Inglis, Williston, Bronson,

20   and Chiefland. In Washington County, the geocoded locations are clustered

1   around Chipley, at the intersection of Interstate 10 and route 77.

2

3   In fact, the 34% geocode rate for the lowest density zone in Florida reported by

4   the sponsors of HAI 5.0a likely overstates the geocode rate in the truly rural areas

5   for this reason. The density zones used to report these geocode rates likely

6   contain both towns and out-of-town areas. Hence, an aggregate geocode rate is

7   typically higher than what is true for the out-of-town areas.

8

9   Q.   IS IT LIKELY THAT ADDRESS-GEOCODED LOCATIONS ACCURATELY

10   REPRESENT THE TRUE DISTRIBUTION OF CUSTOMER LOCATIONS IN

11   THESE WIRE CENTERS?

12   A.   No. By examining **actual** locations relative to geocoded locations, one can see that

13   indeed, geocoded locations tend to be only in and around towns, despite there

14   being housing units scattered throughout the wire center.

15

16   Q.   DID YOU EXAMINE A WIRE CENTER IN RURAL FLORIDA FOR THIS

17   PHENOMENON?

18   A.   Yes. Address-geocoded locations were obtained for the Yankeetown wire center

19   in Levy County. In addition, **actual** customer locations were obtained through the

20   analysis of a satellite image for this wire center.

21

22   Q.   WHAT KIND OF SATELLITE IMAGE WAS USED FOR THE FLORIDA

23   ANALYSIS?

24   A.   The satellite image used is referred to as a "10-meter product". That is, one pixel

25   equals 10 meters on a side. The image was taken on December 4, 1995 from an

1   altitude of 520 miles. It was purchased from SPOT Image Corporation and

2   analyzed by ERIM (Environmental Research Institute of Michigan).

3

4   Q.   HOW WAS THE SATELLITE IMAGE ANALYZED BY ERIM?

5   A.   Since the image is digitized, it can be loaded into a personal computer and

6   enlarged on the computer monitor. ERIM's experienced imagery analysts then

7   visually identified houses on a Census Block by Census Block basis.

8

9   Q.   WHAT DID YOUR ANALYSIS REVEAL?

10 A.   A map of the Yankeetown wire center Exhibit KDD-5 shows the locations of the

11   houses that could be identified from the satellite image locations. Six hundred

12   and thirty-three of the 2,119 housing units in this wire center could be geocoded

13   to the HAI Model standards. It is clear that geocoding does not capture a

14   significant portion of the customer locations in Florida low-density areas.

15   Moreover, Exhibit KDD-5 shows that actual customers are dispersed throughout

16   the wire center.

17

18 Q.   CUSTOMERS WHOSE LOCATIONS CANNOT BE ADDRESS-GEOCODED

19   ARE PLACED ON THE PERIMETER OF CENSUS BLOCKS. IS THERE

20   EVIDENCE THAT CUSTOMERS ARE ACTUALLY LOCATED OTHER

21   THAN ON THE PERIMETER OF CENSUS BLOCKS?

22 A.   Yes there is. It is true that people tend to live along roads. It is also true that

23   roads are not limited to the perimeter of Census Blocks. For example, in Florida,

24   44% of the populated roads in the low-density Census Blocks (densities greater

25   than 0 but less than equal to 20 housing units per square mile) are "interior roads."

13

1   The share of populated road mileage that is interior to Census Blocks for the four

2   lowest density zones in Florida is shown in Table 6.

3

4   **Table 6. Florida Interior Roads**

Density (HU / SQMI)	% of Populated Roads that are Interior to Census Block
< 5	48.2
5 - 20	39.5
20 - 100	38.3
100 - 200	32.7

5

6   In addition, when *INDETEC* geocoded customer locations in the counties of Levy

7   and Washington we found that 32% and 27%, respectively, are located on interior

8   roads. These findings are inconsistent with the placement of all non-geocodable

9   customers on the perimeter of Census Blocks. Thus, HAI inappropriately

10   disregards the fact that customers in rural areas live along both interior and

11   perimeter roads.

12

13 Q.   IS THE PLACEMENT OF SURROGATE LOCATIONS ON THE PERIMETER

14   OF CENSUS BLOCKS A "CONSERVATIVE" ASSUMPTION AS THE HAI

15   PROPONENTS CONTEND?

16 A.   No. By "conservative" I assume the reference is with respect to the *dispersion* of

17   customer locations. Exhibit KDD-6 provides an example of where uniform

18   placement of customer locations along roads both exterior and interior to a Census

19   Block yields a *greater* dispersion (as measured by the Minimum Spanning Tree

20   distance) than uniform placement along the Census Block boundary.

21

14

1   In addition, uniform placement along Census Block boundaries is not

2   conservative if artificial clusters are formed along contiguous Census Block

3   boundaries.

4

5   Q.   HAVE THE DEVELOPERS OF HAI 5.0a PRESENTED AN ALTERNATIVE

6   METHODOLOGY TO THE SURROGATE PLACEMENT YOU DISCUSSED

7   ABOVE?

8   A.   Yes. On March 2, 1998, AT&T filed with the FCC an *ex parte* that presents an

9   "alternative methodology for determining the location of customers who were not

10   geocoded to their precise street address location by the HAI Model, v5.0a." This

11   *ex parte* is attached to my rebuttal testimony as Exhibit KDD-7.

12

13   Q.   WHAT IS THIS ALTERNATIVE METHODOLOGY THAT HAI PRESENTED

14   TO THE FCC?

15   A.   The methodology discussed in this *ex parte* locates customers whose addresses

16   cannot be accurately geocoded within a Census Block on the basis of both interior

17   and boundary roads. This methodology uses the internal Census Block road

18   network much in the same way that BCPM has used all along. The *ex parte*

19   states, "We are currently using the **same** roads that are claimed to be used in

20   BCPM3." (Emphasis added).

21

22   Q.   IS IT TRUE THAT A MODEL WHICH ADDRESS-GEOCODES SOME

23   CUSTOMER LOCATIONS IS NECESSARILY BETTER THAN ONE THAT

24   DOES NOT USE ADDRESS GEOCODING?

25   A.   No. First, the mere use of address-geocoding does not necessarily make a model's

15

1   customer location methodology better than one which uses some other technique

2   to locate customers. This argument is especially suspect in the low-density areas

3   where the address-geocode rate is extremely low. Consequently, the assertion of

4   accuracy of HAI's placement of customers in rural areas depends critically upon

5   the erroneous assumption that customers live on only perimeter roads.

6

7   Second, the degree to which a model uses address-geocoding needs to be

8   determined. For example, as discussed later, the address-geocoded and surrogate

9   locations are used only to define the perimeter of the PNR polygon clusters in the

10   HAI preprocessing stage. Once HAI transforms the PNR clusters, generating new

11   HAI clusters that encompass a different geographic area than the PNR clusters,

12   the customer latitude and longitude information is discarded. This information in

13   no way enters the Access database used by HAI 5.0a.

14

15   Q.   WHAT IS YOUR OVERALL ASSESSMENT OF THE HAI CUSTOMER

16   LOCATION METHODOLOGY?

17   A.   First, the HAI customer location methodology *is* severely limited in its ability to

18   use geocoded data, especially in rural areas. Since the rate of successful address-

19   geocoding is low in rural low density areas, this methodology relies heavily on an

20   inadequate estimate of customer locations. This estimation places customers on

21   the perimeter of Census Blocks, disregarding the fact that customers live along

22   interior roads as well.

23   Secondly, despite claims by the HAI proponents that the HAI customer location

24   methodology more accurately locates customers than BCPM, particularly in the

25   low-density areas, this conclusion is counterintuitive given the limitations just

16

1   described. Furthermore, AT&T has not provided any quantitative evidence to

2   substantiate this claim, nor has it provided the underlying data for the geocoded

3   and surrogate locations as requested by BellSouth in discovery, to permit such an

4   analysis.

5   **B.   BCPM 3.1 Customer Location Methodology**

6   Q.   WOULD YOU PLEASE BRIEFLY REVIEW BCPM'S CUSTOMER

7   LOCATION METHODOLOGY?

8   A.   BCPM 3.1 assumes that customers are located on or near roads and uses detailed

9   road-mileage information to allocate U.S. Census housing units counts within

10   Census Blocks. Specifically, a "fishnet" of microgrids, each roughly 1,500' by

11   1,700', is placed over a wire center. Census Block housing unit counts are then

12   allocated to each microgrid based on each microgrid's share of total Census Block

13   road mileage. The end result is a statistical distribution of customer locations

14   across the microgrids of a wire center. That is, the process yields the *likely*

15   (estimated) location of customers within a wire center.

16

17   Q.   HOW ARE HOUSING UNITS DISPERSED WITHIN A MICROGRID?

18   A.   The customer location methodology results in a housing unit count for each

19   microgrid. However, BCPM effectively assumes, for purposes of estimating

20   distribution cable distances, that housing units are evenly distributed along the

21   roads within a microgrid.

22

23   Q.   DID YOU COMPARE BCPM's CUSTOMER LOCATION PREDICTIONS

24   WITH ACTUAL CUSTOMER LOCATIONS?

1 A. Yes. A key test of any customer location methodology is whether the model's

2   estimated customer locations are consistent with actual customer locations. This

3   is of paramount importance in the rural, low-density area since Census Blocks are

4   quite large in these areas.

5

6   The first step was to choose a BellSouth - Florida wire center in a low-density

7   area. As described earlier, this selection was made randomly and resulted in the

8   Yankeetown wire center in Levy County. ERIM then analyzed two satellite

9   photographs that covered this wire center and identified house locations. These

10   locations (latitudes and longitudes) were then digitized with the result being the

11   map presented as Exhibit KDD-5. As Exhibit KDD-5 shows, house locations are

12   scattered through out the wire center.

13

14   The next step is to overlay this map with concentric circles each with a radius 1-

15   mile greater than the previous circle's. This yields "rings" around the central

16   office "bull's eye" with a width of 1 mile. The idea is to count the number of

17   actual houses that fall within each "ring." These counts are summed and then

18   plotted against the ring's outer-edge distance from the central office. The result is

19   the distribution of actual houses as measured against distance from the central

20   office.

21

22   The map shown in Exhibit KDD-8 (with the concentric rings) is next overlaid

23   with BCPM's microgrids. As noted earlier, housing units are allocated to the

24   microgrids in the wire center based on each one's share of livable road mileage.

25   Using the centroid of the microgrid, each microgrid is assigned to an appropriate

18

1   ring and the number of BCPM predicted housing units is summed for each ring.

2   This step yields the distribution of BCPM predicted housing units as measured

3   against the distance from the central office.

4

5   The actual house and BCPM housing unit distributions for Yankeetown are shown

6   graphically in KDD-9, Figure 1. As one would expect, the majority of houses

7   (62%) is actually located within 3 miles of the central office with the distribution

8   having a "long tail." Figure 1 also shows that the actual and BCPM distributions

9   are a very close match. Since the "actuals" are single, detached-houses and the

10   "predicted" are all housing units, there cannot be an exact one-to-one match.

11   What we are looking for is the tendency of actual locations to lie where BCPM

12   predicts them to be.

13

14   For example, 62% of actual locations are within 3 miles of the central office. The

15   comparable figure for BCPM's predicted housing unit locations is 66%. At 10

16   miles, the percentages are 86 and 88. Moreover, the simple correlation between

17   the actual house counts and BCPM's predicted housing unit counts across the

18   rings is 0.99. Hence, BCPM's customer location methodology, using this

19   benchmark, accurately identifies the actual distribution of customers within this

20   wire center.

21

22   Q.   DID YOU PERFORM A SIMILAR EVALUATION OF THE HAI CUSTOMER

23   LOCATION METHODOLOGY?

24   A.   No. BellSouth requested in discovery that AT&T provide the customer location

25   data necessary to perform this analysis. AT&T claimed that the information is

19

1   proprietary and refused to produce it. Thus, AT&T has refused to provide the

2   data needed to conduct a comparable test of the Hatfield model.

3

4 Q. WHAT IS YOUR OVERALL ASSESSMENT OF THE BCPM CUSTOMER

5   LOCATION METHODOLOGY?

6 A. Since the rate of address-geocoding is extremely low in the areas of primary

7   interest for universal service, most, if not all, customer locations must be

8   estimated in the low-density areas. Using road information is a logical approach

9   for estimating customer locations. Not only is the relationship between Census

10   Block road mileage and housing unit counts empirically verifiable but the

11   methodology is based on a comprehensive database. That is, road data are

12   reasonably complete for every Census Block in the country. Address databases

13   are not.

14

15   Moreover, the soundness of BCPM's approach has been validated by comparing

16   the customer locations predicted by the BCPM model with real-world customer

17   locations. As presented above, such a test of BCPM's road-based methodology

18   indicates that it effectively predicts the actual distribution of houses, as a related

19   to distance from the central office, in the Yankeetown wire center.

20

21 III. CUSTOMER AGGREGATION

22

23 Q. HOW DO THE COST PROXY MODELS USE THE CUSTOMER LOCATION

24   INFORMATION?

25 A. The next step in the modeling process is to aggregate customers into telephone

20

1   serving areas. These serving areas are the fundamental units that are served by the

2   wire-based network. A brief presentation of the models' aggregation process is

3   necessary as it bridges my discussion of the customer location and distribution

4   plant methodologies.

5

6   A.   **HAI 5.0a Customer Aggregation Methodology**

7   Q.   HOW DOES HAI 5.0a FORM ITS TELEPHONE SERVING AREAS?

8   A.   Once the address-geocoded and surrogate customer locations are determined, a

9   process developed by PNR and Associates (PNR) determines clusters of

10   customers. This process is described in the HAI Model Documentation in section

11   5.5. The documentation indicates that there are several criteria used to determine

12   the ultimate size of a cluster. These stated criteria are: (1) no point in a cluster

13   may be more than 18,000 feet distant (based on right angle routing) from the

14   cluster's centroid; (2) no cluster may exceed 1,800 lines in size; and, (3) no point

15   in a cluster may be farther than two miles from it's nearest neighbor. The end

16   result of this process is a set of irregularly shaped polygon clusters.

17

18 Q.   WHAT ARE OUTLIER CLUSTERS?

19 A.   The process described above applies to the "main" clusters, which consist of 5 or

20   more locations. PNR also identifies very small clusters, called outlier clusters,

21   which consist of 4 or less locations. These outlier clusters are "homed" on a

22   parent main cluster and are strung together in HAI 5.0a by T1 road cable. In

23   BellSouths's Florida service territory, there are 5,948 main clusters and 210 outlier

24   clusters. The main clusters account for 99.99% of the locations and 99.99% of the

21

1   lines identified by HAI 5.0a.

2

3   In the discussion that follows, "serving areas" in HAI 5.0a are synonymous with

4   "main clusters."

5

6 Q. VISUALLY, WHAT DO THE PNR POLYGON CLUSTERS LOOK LIKE?

7 A. Given that AT&T refused to provide BellSouth the necessary data when it was

8   requested through the discovery process, it is not possible to graphically depict the

9   actual PNR polygon clusters for a wire center in Florida.

10

11 B. BCPM 3.1 Customer Aggregation Methodology

12

13 Q. PLEASE BRIEFLY REVIEW BCPM'S CUSTOMER AGGREGATION

14   METHODOLOGY?

15 A. Once housing units and business lines are allocated among the microgrids in a

16   wire center, microgrids (along with the estimated locations within each microgrid)

17   are aggregated into telephone Carrier Service Areas (CSAs), referred to as

18   "ultimate grids." Ultimate grids range in size from a single microgrid (in the

19   high-density areas) to approximately 12,000 feet by 14,000 feet, roughly 6 square

20   miles, in the low-density areas.

21

22   In rural, low-density areas, a BCPM ultimate grid situated away from the edge of

23   the wire center is typically a rectangle that is 8 contiguous microgrids wide by 8

24   contiguous microgrids tall.

22

1

2   Q.   VISUALLY, WHAT DOES THE BCPM 3.1 ULTIMATE GRID NETWORK

3   LOOK LIKE?

4   A.   Exhibit KDD-10 shows the Yankeetown wire center with actual locations,

5   overlaid with the BCPM ultimate grids. Also shown is the number of housing

6   units predicted to reside in each ultimate grid. There are 51 ultimate grids in this

7   wire center. The maximum sized grid is 8.3 square miles. BCPM 3.1 places

8   2,392 housing units (1,865 households) in this wire center and 350 business

9   locations.

10

11   Q.   ONCE "ULTIMATE GRIDS" ARE FORMED, HOW ARE CUSTOMER

12   LOCATIONS TREATED WITHIN THE ULTIMATE GRID?

13   A.   Customers are still located within the ultimate grid in the microgrids to which

14   they were originally assigned.

15

16   Q.   HOW DOES THE BCPM CUSTOMER AGGREGATION METHODOLOGY

17   DIFFER FROM THAT USED BY HAI 5.0a?

18   A.   The PNR methodology is a "nearest neighbor" methodology whereby a cluster is

19   formed from the "bottom up." Distance to the nearest neighbor is a primary guide

20   in this process. The BCPM methodology starts with a macrogrid, a $1/25^{th}$ of a

21   degree latitude and longitude grid consisting of, at the most, 64 microgrids, and

22   seeks to determine if this area can be broken into smaller serving areas. Hence,

23   the BCPM methodology is a "top down" approach. Density, or concentrations of

24   lines, is the primary guide in the BCPM process. Both methodologies yield

25   serving areas of varying sizes, with larger areas serving the lower-density zones.

1

2   V.   **DISTRIBUTION PLANT ESTIMATION**

3

4   Q.   WHAT IS THE NEXT STEP IN THE MODELING PROCESS ONCE

5   CUSTOMERS ARE AGGREGATED INTO SERVING AREAS?

6   A.   The next step is to design a distribution network to serve these areas from the

7   current location of the central office. My focus in this section is on whether the

8   models estimate enough "distribution" plant to serve customers in the locations

9   assumed by the models.

10

11 A.   **HAI 5.0a Distribution Distance Estimation**

12 Q.   HOW DOES HAI 5.0a ESTIMATE THE AMOUNT OF DISTRIBUTION

13   CABLE DISTANCE NEEDED TO SERVE CUSTOMERS IN THE

14   LOCATIONS WITHIN THE PNR POLYGON CLUSTERS?

15 A.   This is a multiple step process. The first step is a transformation of the irregularly

16   shaped PNR polygon clusters into rectangles. The second step is placement of

17   customers within these rectangles. The last step is the design of a branch and

18   backbone network to serve these customers.

19

20 Q.   HOW DOES HAI 5.0a TRANSFORM THE PNR CLUSTERS?

21 A.   HAI 5.0a converts PNR's irregular polygons into the model's rectangular serving

22   areas in two steps. First, for each of PNR's polygon clusters, HAI 5.0a forms a

23   "minimum bounding rectangle," a rectangle that exactly bounds the cluster's

24   "convex hull," by enclosing the polygon's four most northerly, southerly, easterly

24

1   and westerly coordinates. (See Exhibit KDD-11 for an illustration.) This

2   minimum bounding rectangle has a North-South, East-West orientation.

3

4   Next, HAI 5.0a converts each minimum bounding rectangle into an "equivalent-

5   area" rectangle. The model performs this second step by forming a rectangle with

6   the same area as the underlying PNR polygon cluster but with the "aspect ratio" of

7   the minimum bounding rectangle. An aspect ratio is the ratio of a rectangle's

8   height to its width. HAI 5.0a uses the resulting equivalent-area rectangles as the

9   telephone serving areas *internal to HAI 5.0a*. That is, these are the areas to which

10   the HAI model "builds plant."

11

12   Q.   WHAT DO THE MAIN, "EQUIVALENT-AREA" RECTANGULAR

13   CLUSTERS LOOK LIKE IN FLORIDA?

14   A.   Exhibit KDD-12 shows the Yankeetown wire center and the rectangular clusters

15   as derived from the cluster Access database accompanying HAI 5.0a. In this wire

16   center, HAI 5.0a assumes there are 15 main clusters and 3 outlier clusters.

17   Ninety-nine point eight percent of the locations assumed to exist in this wire

18   center are placed into the main clusters. The largest main cluster is 13.8 square

19   miles. In the State as a whole, the largest HAI 5.0a cluster is 20.2 square miles in

20   size.

21

22   Q.   ONCE THE RECTANGULAR MAIN CLUSTERS ARE FORMED, FOR

23   MODELING PURPOSES, HOW ARE CUSTOMERS LOCATED WITHIN

24   EACH RECTANGULAR CLUSTER?

25   A.   HAI 5.0a assumes that customer lots are, essentially, evenly distributed within

25

1   each cluster.

2

3   Q.   HOW DOES HAI 5.0a DESIGN THE DISTRIBUTION NETWORK WITHIN

4   THE MAIN, RECTANGULAR CLUSTERS?

5   A.   Distribution plant is modeled in a simple branch and backbone configuration.

6   HAI 5.0a assumes customer lots are essentially evenly distributed within each

7   main cluster. Each lot is assumed to be twice as tall as it is wide. The size of

8   each lot is simply the area of the polygon cluster divided by the number of

9   locations. If the model determines that more than one DLC is needed, then

10   connecting cable is also placed to connect the centroid of the main cluster (where

11   the subfeeder terminates) with the DLCs.

12

13   Q.   DO THE EQUIVALENT-AREA, RECTANGULAR MAIN CLUSTERS

14   CONTAIN ANY INFORMATION ON THE LOCATION OF THE ADDRESS-

15   GEOCODED AND SURROGATE LOCATIONS USED TO DEFINE THE PNR

16   POLYGON CLUSTERS?

17   A.   No. The equivalent-area rectangles are a modeling tool used by HAI 5.0a to

18   estimate the amount of distribution cable needed to serve customers in the

19   locations within the associated PNR polygon clusters. The address-geocoded and

20   surrogate locations are used only in the determination of the PNR polygon

21   clusters. Once the shape and area of the PNR polygon clusters are determined, the

22   information on the geocoded and surrogate locations is no longer used by HAI

23   5.0a.

24

25   A visual representation may help. KDD-13, Figure 2 shows a stylized PNR

26

1   polygon cluster (on the left) with 19 locations spatially located. Information on

2   the exact spatial placement (by PNR) of these 19 locations is not provided in the

3   HAI 5.0a Access database nor is information on the shape of the polygon cluster

4   provided. We only know that there are 19 locations associated with this cluster as

5   well as the area, location, and dimensions of the equivalent-area rectangle. What

6   is provided in the HAI 5.0a Access database is the corresponding equivalent-area

7   rectangle shown in Figure 2 (on the right).

8

9   Q.   DO YOU HAVE A CONCERN WITH HOW THESE EQUIVALENT-AREA

10   RECTANGULAR CLUSTERS ARE FORMED?

11   A.   Yes, since these rectangles are used in the determination of distribution plant

12   distances. The concern with these rectangular clusters is that, although the actual

13   sizes and shapes of the underlying (polygon) clusters are not revealed, the

14   equivalent-area rectangles can bear little relationship to the underlying shape of

15   the PNR polygon cluster. Exhibit KDD-11 discusses this in detail.

16

17   Q.   WHY IS IT AN ISSUE IF THE RECTANGULAR CLUSTER BEARS LITTLE

18   RESEMBLANCE TO THE SHAPE OF THE UNDERLYING PNR CLUSTER?

19   A.   The concern is that the transformation process can effectively result in a reduction

20   of customer dispersion. That is, the dispersion of customers *assumed* for

21   estimating distribution distances can be less than the level of dispersion that

22   occurs in the underlying PNR polygon cluster. The result is that HAI 5.0a can

23   estimate too little distribution distance to connect customers in the locations

24   within the PNR clusters.

25

27

1 Q. CAN YOU PROVIDE A VISUAL DEMONSTRATION OF THIS ISSUE?

2 A. Certainly. KDD-13, Figure 3 shows a cluster of customer locations, some

3   geocoded, some surrogate. This polygon cluster is transformed by HAI 5.0a into

4   a rectangle that is used in the estimation of distribution plant. Although HAI 5.0a

5   constrains the area of the rectangular cluster to the area of the PNR polygon

6   cluster, the resulting rectangular cluster may bear little resemblance to the shape

7   of the underlying PNR polygon cluster of customer locations. The original

8   customer locations as well as the original distance between these locations are not

9   preserved in the transformation process.

10

11 Q. DO YOU HAVE A CONCERN WITH THE HAI 5.0a DISTRIBUTION

12   NETWORK DESIGN WITHIN THE MAIN RECTANGULAR CLUSTERS?

13 A. Yes. There is an assumption that reinforces the effect on the estimated

14   distribution distance caused by the compression of customer dispersion discussed

15   above. This assumption concerns the placement of the branch and backbone cable

16   within the main rectangular clusters.

17

18   After producing the customer lots, HAI 5.0a places backbone distribution cable

19   vertically and branch cable horizontally. Because branch and backbone cable

20   extends to within one lot width (depth) from each rectangle's boundary, low-

21   density rectangles are characterized by locations (i.e., structures) that must be

22   compressed around the interior lots in order to be reached. Now this is not a

23   problem in clusters that are densely populated. However, in sparsely populated

24   clusters, the assumed lots are very large and the compression around the interior

25   lots is much greater. The total effect of the transformation process coupled with

28

1   this assumption concerning branch and backbone length is a tendancy to

2   underestimate the distribution distance. Again, Exhibit KDD-11 illustrates how

3   this underestimation can occur.

4

5   Q.   WHAT MEASURE CAN BE USED TO QUANTIFY THE EXTENT TO

6   WHICH THE HAI 5.0a UNDERSTATES DISTRIBUTION DISTANCE?

7   A.   The Minimum Spanning Tree ("MST") can be used to provide an appropriate

8   lower bound for quantifying customer dispersion. The MST is the most

9   conservative measure of the minimum distance required to connect all customer

10   locations. As such, it provides a measure of customer dispersion.

11

12   Simply, the MST of a set of points is that set of connecting line segments whose

13   total length is the *shortest possible* for this set of points. The attached paper,

14   "Using Minimum Spanning Trees to Estimate Subscriber Dispersion and

15   Minimum Network Length" (Exhibit KDD-14) provides further rationale for the

16   usefulness of the MST. The attached paper also provides a step-by-step example

17   of how a MST is calculated.

18

19   Q.   IN REALITY, ARE NETWORK DISTRIBUTION DISTANCES LIKELY TO

20   EXCEED THE MST DISTANCE?

21   A.   Yes, for the simple reason that actual distribution distances likely exceed the MST

22   distance. For example, actual distribution paths must adhere to rights of way

23   (e.g., streets). The MST ignores any such constraints and simply measures the

24   shortest way to connect houses with a straight line. As such, a MST segment will

25   traverse straight across a lake rather than follow a road around the lake to reach

1   the other side.

2

3 Q. CAN YOU PROVIDE AN ANALOGY TO HELP EXPLAIN THE MST

4   CONCEPT?

5 A. Yes. Suppose that an interstate highway is to be constructed directly between

6   Gainesville and Jacksonville. We know that as the crow flies, the aerial distance

7   between these two cities is approximately 65 miles. Clearly, the constructed

8   interstate that connects these two cities cannot be shorter than 65 miles. If it were

9   then cars would have to "fly" over the gaps in the highway. Realistically, the

10   amount of interstate highway distance constructed would be greater than the

11   "crow" distance as natural barriers, rights-of-way, and other obstacles would have

12   to be factored into the routing of the highway.

13

14   Hence, the MST distance should be considered as a "reality check," not as the

15   amount of distribution distance that a model should estimate. A model should

16   estimate a distribution distance that *exceeds* the MST distance.

17

18 Q. SHOULD THE MINIMUM SPANNING TREE DISTANCE BE CONSIDERED

19   A 'LOWER BOUND' FOR A REQUIRED AMOUNT OF DISTRIBUTION

20   DISTANCE?

21 A. The MST should not be considered as a "lower bound" for a required amount of

22   distribution distance. Such a lower bound likely *exceeds* the MST for the reason

23   given above. Our analysis is based on the premise that if a model's calculated

24   distribution distance is less than the MST distance, then it is less than the

30

1   minimum distance required for a functional distribution network.

2

3   Q.   IS IT TRUE THAT THE MST DISTANCE MAY NOT BE THE SHORTEST

4   DISTANCE CONNECTING A SET OF POINTS?

5   A.   Theoretically speaking, yes. By adding points (nodes) one *may* be able to reduce,

6   under certain conditions, the distance needed to connect the original set of points.

7   However, in most cases of interest, i.e., *greater than 5 locations*, it is very

8   difficult to find a connecting distance that is less than the MST distance. Exhibit

9   KDD-15 discusses this in more detail.

10

11   Q.   DOES THE MST TEST THAT YOU ARE PROPOSING CONSIDER ACTUAL,

12   I.E., "REAL-WORLD," CUSTOMER LOCATIONS?

13   A.   No. It is important to realize that the test I am proposing is one for examining

14   whether HAI 5.0a estimates enough distribution cable distance to connect the

15   customers in the locations *assumed by HAI 5.0a, i.e., in the PNR clusters*, not in

16   their "real-world" locations. A *comprehensive* database on the real-world

17   locations of *all* customers is *not* available. Hence, this is a test of a model's

18   "internal consistency."

19

20   Q.   DID YOU USE THE MST TO DETERMINE IF HAI 5.0a UNDERESTIMATES

21   DISTRIBUTION DISTANCE FOR BELLSOUTH'S FLORIDA SERVICE

22   TERRITORY?

23   A.   Yes. We first calculated the MST distance for each PNR irregular polygon falling

24   within BellSouth's wire centers in Florida. The MST distance represents the

31

1   minimum distance required to connect the geocoded and surrogate coordinates

2   encompassed by each polygon. For each *corresponding* equivalent-area,

3   rectangular main cluster formed by HAI 5.0a, we then compared the MST

4   distance with the distribution route distance calculated by HAI 5.0a. In making

5   this comparison, we added drop lengths and connecting cable lengths to the

6   distribution route distance calculated by HAI 5.0a.

7

8   Q.   DID YOU ACQUIRE THE COORDINATES FOR THE GEOCODED AND

9   SURROGATE LOCATIONS FROM THE ACCESS DATABASE THAT

10   ACCOMPANIES HAI5.0a?

11   A.   No. As discussed earlier, the Access database that accompanies the HAI model

12   does not contain any information on the original locations in the PNR polygon

13   clusters. A data request was made of AT&T to obtain the MST distance, based on

14   a program supplied to AT&T by StopWatch Maps. We received for each HAI

15   5.0a cluster the MST distance, but was not provided any geocoded or surrogate

16   locations.

17

18   Q.   HOW ARE YOU DEFINING "UNDERSTATEMENT OF DISTRIBUTION

19   DISTANCE"?

20   A.   An understatement or "shortage" occurs if the MST distance is greater than the

21   distribution route distance calculated by HAI 5.0a. Again, this does not imply

22   that the MST is a lower bound for a required amount of distribution distance. It

23   simply means the model is not providing for enough distribution distance to

24   connect all the customer locations identified by PNR in the underlying polygon

25   cluster *using the shortest distance configuration that is theoretically possible*.

32

1

2 Q.   WHAT DID YOUR CALCULATIONS OF THE PERTINENT MINIMUM

3   SPANNING TREES REVEAL?

4 A.   Using the HAI 5.0a default drop lengths, we calculated the difference between the

5   MST distance and the distribution route distance calculated by HAI 5.0a for each

6   main cluster. Table 9 presents a summary of our findings, again by density zone.

7   Table 9 shows the cumulative amount by which the HAI 5.0a calculated

8   distribution route distance falls short of the MST distance ("shortage"), the

9   cumulative MST for the clusters that are short, the average shortage, the number

10   of main clusters that are short, the number of main clusters in each density zone,

11   and the percentage of main clusters that are short.

12

13   HAI 5.0a does not use the 5 - 20 and 20 - 100 density zones but considers only the

14   aggregate 5 - 100 density zone. To provide greater detail for low-density areas,

15   we provide data for these two subcategories.

16

17   **Table 9. HAI 5.0a Distribution Route Distance Understatement:**

Default Drop Lengths, BellSouth Florida

Data for Only Main Clusters That Are Short

DZ	HAI MC Dist Route Feet Shortage	MST for Short MC	% Short	Number of MC Short	Number of MC in DZ	Number of MC Short In DZ (%)
< 5	2,784,677	6,569,067	42.39%	136	157	86.62%
5 - 20	4,491,981	15,795,651	28.44%	265	396	66.92%
20 - 100	1,793,590	7,124,473	25.18%	142	415	34.22%
100 - 200	300,093	1,384,879	21.67%	31	227	13.66%

200 - 650	192,303	687,053	27.99%	32	604	5.30%
650 - 850	10,600	46,356	22.87%	5	216	2.31%
850 - 2,550	163,312	1,099,637	14.85%	43	1,491	2.88%
2,550 - 5,000	64,046	624,884	10.25%	31	1,376	2.25%
5,000 - 10,000	35,165	291,621	12.06%	24	832	2.88%
> 10,000	18,648	130,309	14.31%	15	234	6.41%
	9,854,415	33,753,930	29.19%	724	5,948	12.17%

1   As Table 9 indicates, HAI 5.0a significantly underestimates the required distance

2   to simply connect the customers, as the crow flies, to the network. The

3   understatement by HAI 5.0a of distribution distance is greatest in the lower

4   density areas, specifically, zones with fewer than 20 lines per square mile.

5   Generally, the understatement declines as density rises. Estimated distribution

6   distances that are short of the MST distance characterize 87% of the main clusters

7   in the lowest density zone. This shortage in the lowest density zone is, on

8   average, 42%. For BellSouth's entire Florida service territory, HAI 5.0a

9   understates distribution distance by at least 9.9 million feet (1,866 miles) using

10   the HAI 5.0a default drop lengths.

11

12   Q.   IS IT LIKELY THAT THE PLACEMENT OF SURROGATE LOCATIONS ON

13   THE PERIMETERS OF CENSUS BLOCKS LEADS TO AN

14   OVERSTATEMENT OF THE MST DISTANCES FOR THE PNR POLYGON

15   CLUSTERS?

16   A.   No. Exhibit KDD-6 shows that a placement of locations on interior and boundary

17   roads can lead to greater dispersion than placement just on the Census Block

18   perimeter. Hence, this counters the argument that the MST distances calculated

34

1   for the PNR clusters are "too long," and the shortage in distribution distance is

2   overstated, because of the location of the surrogate points along the perimeter of

3   the Census Block boundaries.

4

5 Q.   IS IT MORE APPROPRIATE TO FOCUS ON THE GROSS SHORTAGE OR

6   NET SHORTAGE IN DISTRIBUTION DISTANCE?

7 A.   It is more appropriate to focus on the gross shortage in distribution distance.

8   First, a definition of terms is in order. A gross shortage is the total shortage that

9   occurs across main clusters when only the distribution distance shortages are

10   added together. A net shortage is the total shortage that occurs when both

11   shortages and "surpluses" are added together across main clusters.

12

13   Now, the shortage in one cluster (for which the MST distance exceeds the

14   distribution distance calculated by HAI 5.0a) cannot be offset by another cluster

15   for which the opposite is true. There are two reasons. First, the MST is not a

16   "lower bound" distribution distance for a functional network. Second, and more

17   fundamentally, distribution cable is not fungible across distribution areas.

18   Because a *physical* network is being modeled, 100 feet of distribution distance

19   beyond the MST amount in cluster X cannot be used to offset a 100 feet

20   deficiency in distribution distance in cluster Y. Each and every cluster should

21   have an appropriate amount of distribution distance so that *everyone* on the

22   modeled network can "talk," not just the "average" customer.

23

24 Q.   BUT IF THE OBJECTIVE IS A COST ESTIMATE, THEN WHY DOES IT

25   MATTER THAT THE MODEL IS SHORT IN SOME CASES IF THERE ARE

1   POSSIBLE OFFSETS ELSEWHERE IN THE MODEL?

2   A.   First, there has been no quantification of any offsets in HAI 5.0a. A *quantified*

3   shortage cannot be offset by a *speculated* overestimation. Second, from a

4   modeler's perspective, an identified error in the model should be fixed. This is

5   true whether it results in an under- or overestimation. This is particularly true

6   considering the use that will be made of the model selected, the identification of

7   high cost areas. The Hatfield proponents have suggested, in affect, that

8   overestimation of costs in each area will somehow average out. This is patently

9   inconsistent with the development of a fund to support Universal Service in high

10   cost areas. This process requires that cost be accurately determined for each high

11   cost area.

12

13   Q.   WHAT IS YOUR OVERALL ASSESSMENT OF THE HAI 5.0a

14   DISTRIBUTION DISTANCE ESTIMATION METHODOLOGY?

15   A.   The methodology can clearly result in too little distribution distance being

16   estimated by the model. That is, in many cases, the HAI model does not estimate

17   enough distribution distance to connect customers in the locations assumed by the

18   model. This underestimation is the most severe in the low-density areas, the areas

19   of concern for universal service purposes. Hence, the model is not internally

20   consistent. A MST check should be included as part of the distribution distance

21   estimation methodology.

22

23   **B.**   **BCPM Distribution Distance Estimation**

24   Q.   HOW DOES BCPM 3.1 ESTIMATE THE AMOUNT OF DISTRIBUTION

1   CABLE DISTANCE NEEDED TO SERVE CUSTOMERS IN THEIR

2   MICROGRID LOCATIONS WITHIN THE BCPM SERVING AREAS?

3 A.   BCPM employs two modeling tools in this estimation. First, each ultimate grid is

4   divided into 4 potential "distribution quadrants," with the "cross hairs" being at

5   the road-centroid of the ultimate grid. Subfeeder then extends into each ultimate

6   grid to the road-centroid of the ultimate grid. In low-density areas, this is where

7   the DLC is located. Horizontal and vertical connecting cable extend from the

8   DLC to each *populated* distribution quadrant of the ultimate grid. The connecting

9   cable terminates at the road-centroid of each populated distribution quadrant.

10

11 Q.   HOW IS THE AMOUNT OF BRANCH AND BACKBONE CABLE

12   DISTANCE NEEDED TO SERVE THE CUSTOMERS IN EACH POPULATED

13   DISTRIBUTION QUADRANT DETERMINED?

14 A.   This is determined with the aid of another modeling tool. An area equal in size to

15   1,000' times the amount of road mileage within a populated distribution quadrant

16   is conceptualized. This area is assumed to be a square consisting of equal sized

17   customer lots. Branch and backbone cable is then "laid" to serve each lot.

18

19 Q.   HAVE YOU APPLIED THE MST REALITY TEST TO BCPM IN FLORIDA?

20 A.   Yes, I have. I performed a test on BCPM 3.1 for BellSouth's service territory in

21   Florida. The relevant unit of analysis in BCPM 3.1 is the Carrier Serving Area or

22   "ultimate grid." The MST is computed for each ultimate grid based on the

23   assumption that customer locations are evenly distributed along roads.

24

25 Q.   HOW SHOULD THE TERM "DISTRIBUTION" BE USED TO ANALYZE

1   BCPM'S DISTRIBUTION NETWORK USING THE MST TEST?

2   A.   The issue is whether BCPM is estimating enough cable distance to connect

3   customers to each other *and* to the network. Hence, "distribution" cable should

4   include all cable on the customer's side of the subfeeder termination point in the

5   serving area, i.e., ultimate grid. This distance includes branch, backbone, drop,

6   and connecting cable distance. For the purpose of the MST test, connecting cable

7   is always defined as "distribution" cable regardless of the location of the FDI.

8

9   Q.   WHAT ARE YOUR FINDINGS FOR BCPM?

10   A.   The findings are presented in Table 10.

11

12   **Table 10. BCPM 3.1 Distribution Route Distance Understatement:**

13   **Default Drop Lengths BellSouth Florida**

14

Data for Only Grids That Are Short

DZ	BCPM Dist Route Feet Shortage	MST for Short Grids	% Short	Number of Grids Short	Number of Grids in DZ	Number of Grids Short in DZ (%)
< 5	1,136,087	5,387,477	21.09%	256	806	31.76%
5 - 20	621,726	3,991,302	15.58%	106	703	15.08%
20 - 100	349,609	770,058	45.40%	22	751	2.93%
100 - 200	82,343	205,984	39.98%	8	536	1.49%
200 - 650	86,867	177,997	48.80%	12	1,931	0.62%
650 - 850	18,399	19,563	94.05%	4	836	0.48%
850 - 2,550	109,886	224,708	48.90%	16	4,975	0.32%
2,550 - 5,000	9,634	35,370	27.24%	4	1,223	0.33%
5,000 - 10,000	26,507	26,507	100.00%	1	40	2.50%
> 10,000	12,958	12,958	100.00%	1	5	20.00%

| 2,454,016 | 10,851,924 | 22.61% | 430 | 11,806 | 3.64% |

1

2   In Table 10, the data are for the ultimate grids for which the MST distance

3   exceeds the amount of distribution cable estimated by the model (i.e., "short"

4   grids). In addition, BCPM 3.1 does not use the 5 - 20 and 20 - 100 density zones

5   but considers only the aggregate 5 - 100 density zone. To provide greater detail

6   for low-density areas, we provide data for these two subcategories.

7

8 Q. WHAT DOES TABLE 10 SHOW?

9 A. In the areas of interest for universal service, i.e., the *two* lowest density zones, the

10   data in Table 10 show that BCPM 3.1 does not estimate enough distribution

11   distance to connect customers in their estimated locations in 24% of its ultimate

12   grids. Considering the entire BellSouth Florida service territory, BCPM's

13   estimated distribution distance falls short of the MST distance in 4% of the

14   ultimate grids. The total "shortage" is at least 2.5 million feet or 465 miles of

15   distribution distance.

16

17 Q. WHAT IS YOUR OVERALL ASSESSMENT OF BCPM'S DISTRIBUTION

18   DISTANCE ESTIMATION PROCESS?

19 A. The results indicate that BCPM is much more internally consistent than HAI 5.0a.

20   That is, BCPM more effectively estimates a minimum required distribution

21   distance (i.e., the MST distance) to connect customers in the locations estimated

22   by the model.

23

24 Q. CAN ONE COMPARE THE BCPM MST RESULTS WITH THOSE OF THE

39